From Individuals to Populations: Modeling Aquatic Toxicity Data Across Levels of Biological Organization

Sandy Raimondo
Research Biologist
U.S. EPA Office of Research and Development (ORD)/National Health and Environmental Effects Research Laboratory (NHEERL)/Gulf Ecology Division (GED)
(850) 934-2424
raimondo.sandy@epa.gov

Authors: Sandy Raimondo, Charles L. McKenney
U.S. EPA ORD/NHEERL/GED
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The Office of Prevention, Pesticides, and Toxic Substances (OPPTS) requires efficient methods to evaluate the ecological effects of thousands of chemicals. Ecological risk assessment is moving toward using population models rather than individual-level response data to make ecological assessments. A critical step in estimating ecological effects of a toxicant is extrapolating individual-level response data across higher levels of biological organization. Several methods using partial life cycle data are gaining attention as a way to obtain quick and easy individual-level effects for input into demographic population models. However, more information is needed on the translation of individual-level effects to population-level response to determine whether partial life cycle tests provide enough information to effectively project population-level consequences. We explored the individual-to-population link using individual response data collected from life cycle tests of the mysid, *Americamysis bahia*, exposed to a range of concentrations of six toxicants and matrix population models developed for each toxicant concentration. Individual-level observations included no effect, delayed reproduction, reduced overall reproduction, or both reduced overall reproduction and survival. A Kruskal–Wallis comparison of population growth rates modeled from each concentration and grouped according to individual-level response showed that population growth rates were significantly less than control growth rates only for concentrations in which overall reproduction and both reproduction and survival were significantly less than the control on the individual level. This indicates that not all individual-level responses result in population-level effects (i.e,. delayed reproduction). Decomposition analysis of the significant population-level effects identified reproduction as the primary contributor to reduced population growth rate at all sublethal concentrations and most lethal concentrations. Mortality was the primary contributor to reduced population growth rate only where survival was less than 25% of control survival. These results suggest the importance of altered reproduction throughout the life cycle on the population-level responses and emphasize the need for complete life cycle test data to make an explicit link between the individual and population levels.